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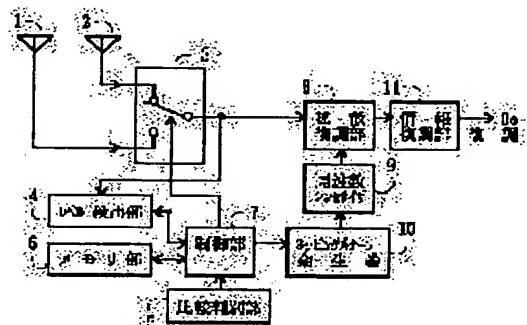
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(57)Abstract:

**SOLUTION:** The spread spectrum signal of the frequency hopping system, which is received by the first reception antenna 1, is sent to a reception level detection part 4. The respective levels of the signals of received frequencies  $f_1$ – $f_n$  are detected and reception level data is stored in a memory part 6. A control part 7 changes over a switch circuit 3 to a second reception antenna 2-side and detects the levels of the signals of the frequencies  $f_1$ – $f_n$ . The control part 7 compares the reception levels of two antennas by the same frequencies and stores the stronger antenna in the memory part 6 in accordance with the respective frequencies. The control part 7 changes over the switch circuit 3 for the respective hopping frequencies  $f_1$ – $f_n$  and of the stronger reception level.



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CLAIMS

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[Claim(s)]

[Claim 1] In a spectrum diffusion radio communication equipment which receives a spectrum diffusion signal of a frequency-hopping method A change over circuit which switches two or more receiving antennas and said two or more receiving antennas, A receiving level detection means to detect receiving level of each input-signal frequency which comes to carry out hopping for said each of two or more receiving antennas of every, A comparison distinction means to compare receiving level for every receiving antenna detected with said receiving level detection means with the same frequency, to take lessons from whether receiving level of which receiving antenna is high, and to distinguish, While controlling the memory section which a receiving antenna with high receiving level distinguished with said comparison distinction means is made to correspond for every input-signal frequency which comes to carry out hopping, and memorizes it, and said receiving level detection means, a comparison distinction means and the memory section A spectrum diffusion radio communication equipment characterized by coming to have a control section which controls said change over circuit to carry out a change over setup to a receiving antenna of a side with high receiving level for each of every hopping-coming-input signal frequency based on stored data of this memory section.

[Claim 2] A spectrum diffusion radio communication equipment according to claim 1 characterized by detecting detection of receiving level by said receiving level detection means in a preamble period before data period initiation in an input signal.

[Claim 3] A spectrum diffusion radio communication equipment according to claim 2 which makes it the feature as detection of receiving level in said preamble period is performed for every packet in an input signal and it comes to update stored data of said memory section.

[Claim 4] A spectrum diffusion radio communication equipment according to claim 2 which makes it the feature as the timer section is prepared in a basis of said control section, receiving level detection in said preamble period is performed for every measurement of predetermined time by said timer section and it comes to update stored data of said memory section.

[Claim 5] A spectrum diffusion radio communication equipment according to claim 1 carried out as the feature to receiving level which said comparison distinction means makes the last once memorize receiving level of each receiving antenna except a receiving antenna which makes change over selection in said memory section among said two or more receiving antennas, and comes to memorize said, and said last as it comes to carry out comparison distinction of each level of a receiving antenna which made change over selection.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] This invention relates to a spectrum diffusion radio communication equipment, and relates to the space diversity reception which was mainly suitable for reception of the spectrum diffusion signal by the low-speed frequency-hopping method at details more.

[0002]

[Description of the Prior Art] Diversity reception technology is known as one of the methods of coping with communication environment aggravation, such as a fading phenomenon. On the other hand, in the communication link field of a spectrum diffusion method, the RAKE receiving method is learned in the direct diffusion spectrum diffusion method, and use is also carried out. In addition, unlike the general diversity of switching an antenna, the above-mentioned RAKE receiving method functions by the interior action, identifies the signal which has passed along the multipath respectively according to the fading phenomenon, and compounds by performing weighting of reliability, and adaptive equalization technology is used for it. That is, it is the method of removing distortion of the coherence of an input signal and realizing a diversity. On the other hand, generally about a frequency-hopping spectrum diffusion method, implementation of a diversity can say that it is difficult compared with a direct diffusion method from the special feature on the principle that a carrier frequency carries out hopping. The above-mentioned special feature to an effect is low only by switching an antenna under frequency-selective fading which serves as a fading phenomenon especially in a specific frequency range.

[0003]

[Problem(s) to be Solved by the Invention] As mentioned above, generally in a frequency-hopping spectrum diffusion method, implementation of a diversity can say that it is difficult compared with a direct diffusion method. This invention aims at offering the spectrum diffusion radio communication equipment which made possible space diversity which was mainly suitable for reception of the spectrum diffusion signal by the low-speed frequency-hopping method in view of \*\*\*\*.

[0004]

[Means for Solving the Problem] In a spectrum diffusion radio communication equipment with which this invention receives a spectrum diffusion signal of a frequency-hopping method A change over circuit which switches two or more receiving antennas and said two or more receiving antennas, A receiving level detection means to detect receiving level of each input-signal frequency which comes to carry out hopping for said each of two or more receiving antennas of every, A comparison distinction means to compare receiving level for every receiving antenna detected with said receiving level detection means with the same frequency, to take lessons from whether receiving level of which receiving antenna is high, and to distinguish, While controlling the memory section which a receiving antenna with high receiving level distinguished with said comparison distinction means is made to correspond for every input-signal frequency which comes to carry out hopping, and memorizes it, and said receiving level detection means, a comparison distinction means and the memory section Based on stored

data of this memory section, a spectrum diffusion radio communication equipment which comes to have a control section which controls said change over circuit to carry out a change over setup to a receiving antenna of a side with high receiving level for each of every hopping-coming-input signal frequency is offered.

[0005] Moreover, detection of receiving level by said receiving level detection means is detected in a preamble period before data period initiation in an input signal.

[0006] Moreover, detection of receiving level in said preamble period is performed for every packet in an input signal, and stored data of said memory section is updated.

[0007] Or the timer section is prepared in a basis of said control section, receiving level detection in said preamble period is performed for every measurement of predetermined time by said timer section, and you may make it update stored data of said memory section.

[0008] Moreover, said comparison distinction means is made to carry out comparison distinction of each level of a receiving antenna which made change over selection at receiving level which make the last once memorize receiving level of each receiving antenna except a receiving antenna which makes change over selection in said memory section among said two or more receiving antennas, and it comes to memorize said, and said last.

[0009]

[Embodiment of the Invention] Hereafter, the gestalt of implementation of invention is explained with reference to a drawing based on an example. Drawing 1 is the important section block diagram showing one example of the spectrum diffusion radio communication equipment by this invention, and makes a receiving antenna 2 sets. Moreover, drawing 2 is explanatory drawing about drawing 1. In drawing 1, they are the change over circuit where the 1st receiving antenna and 2 switch the 2nd receiving antenna, and, as for 3, 1 switches said antenna, the receiving level detecting element to which 4 detects receiving level, the comparison distinction section to which 5 carries out comparison distinction of the strength of receiving level, the memory section 6 memorizes the distinction result of the comparison distinction section 5, and the control section 7 controls change over control of said change over circuit 3, and the comparison distinction section 5 and memory section 6 grade. Moreover, a hopping pattern generator for the diffusion recovery section from which 8 recovers the spectrum diffusion signal of a frequency-hopping method, the frequency synthesizer with which 9 supplies a necessary frequency oscillation signal to the diffusion recovery section 8, and 10 to make the oscillation frequency of said frequency synthesizer 9 in agreement with the basis of control of said control section 7 to the hopping pattern of a transmitting side, and 11 are the information recovery sections which make an information recovery (recovery of QPSK etc.).

[0010] Next, actuation of this invention is explained. A control section 7 sets up the change over circuit 3 so that either of 2 sets of receiving antennas may be chosen. This selection shall choose the 1st receiving antenna 1 by this example that what is necessary is just to set beforehand. The spectrum diffusion signal of the frequency-hopping method received with the 1st receiving antenna 1 is sent to the receiving level detecting element 4. The frequency of pattern 1 period of frequency hopping is  $f_1 \rightarrow f_2 \rightarrow f_3$  here. -- It shall change in order of  $\rightarrow f_n$ . The receiving level detecting element 4 detects the frequency  $f_1$  received with the 1st receiving antenna 1 thru/or the level of each signal of  $f_n$ . It is made to perform this detection at the preamble period shown in drawing 2 (A).

[0011] This preamble period is established before data period initiation like illustration, and that purpose is mainly used as a period for taking a transmitting side and a synchronization in a receiving side. After this synchronization is taken, an original data period is started. Moreover, the receiving level detecting element 4 performs level detection of a count equal to the above-mentioned preamble period in the number of the antennas used. Therefore, in the case of drawing 1, since the antenna is made into 2 sets, two level detection containing the 2nd below-mentioned receiving antenna 2 will be performed, and level detection is each carried out per 2nd receiving antenna 2 the second half per 1st receiving antenna 1 in the first half of a preamble period. The receiving level data of the 1st receiving antenna 1 is memorized in the memory section 6. A control section 7 carries out level detection of the change over circuit 3 about frequency  $f_1$  thru/or each signal of  $f_n$  like the case of a switch and the 1st receiving antenna 1

to the 2nd receiving-antenna 2 side after detecting the receiving level of the 1st receiving antenna 1.

[0012] A control section 7 makes the same frequency compare the receiving level of 2 sets of antennas from  $f_1$  to  $f_n$ , attaches it to whether which one has large level, and makes the receiving level of the 2nd receiving antenna 2 distinguish in the comparison distinction section 5 after detection initiation. This comparison distinction carries out comparison distinction of the level of  $f_1$  by said 1st receiving antenna 1 which it comes to memorize in this level and the memory section 6 after detecting the level of  $f_1$  by the 2nd receiving antenna 2, makes the antenna of a strong side correspond with  $f_1$ , and is stored in the memory section 6. You perform same comparison distinction from  $f_2$  to  $f_n$ , you make it correspond with each frequency, and the antenna of a strong side is stored in the memory section 6. Consequently, the data of the proper antenna set up to each frequency ( $f_1$  thru/or  $f_n$ ) of hopping pattern 1 period (selection) is stored in the memory section 6. Drawing 2 (B) illustrates the above-mentioned comparison distinction,  $E_1$  thru/or  $E_n$ , and receiving level of the 2nd receiving antenna 2 (A2) are set to  $e_1$  thru/or  $e_n$  for the receiving level of the 1st receiving antenna 1 (A1) to the frequency ( $f_1$  thru/or  $f_n$ ) of hopping pattern 1 period, and it is shown that the "setting antenna" as a result of comparison distinction is A1 or A2. A control section 7 sets the change over circuit 3 to every hopping frequency ( $f_1$  thru/or  $f_n$ ) in a data period [ drawing 2 (B) ] to an antenna side with powerful switch and receiving level based on this data after storing the above-mentioned setting antenna data in the memory section 6.

[0013] As timing which performs comparison distinction of the receiving level of explanation above, it carries out at the preamble period for every packet, and the storing data of the memory section 6 is updated. or — The timer section (not shown) is prepared in the bottom of a control section 7, the above-mentioned comparison distinction is performed for every predetermined time, and you may make it update the storing data of the memory section 6 similarly. The input signal chosen in the change over circuit 3 is inputted into the diffusion recovery section 8, and a spectrum diffusion recovery is carried out. The oscillation signal of the necessary frequency required in the case of this recovery is supplied from a frequency synthesizer 9, and the oscillation frequency of this frequency synthesizer 9 follows the hopping pattern of the hopping pattern generator 10. In addition, this hopping pattern is a transmitting side and this pattern, and operates under control of a control section 7. The diffusion recovery output from the diffusion recovery section 8 is sent to the information recovery section 11, an information recovery (recovery to QPSK etc.) is carried out here, and the recovery output of Data Do is obtained. The space diversity in reception of the spectrum diffusion signal according to a low-speed frequency-hopping method as mentioned above mainly becomes possible.

[0014]

[Effect of the Invention] As explained above, according to this invention, the space diversity in reception of the spectrum diffusion signal by the frequency-hopping method becomes possible. Although a frequency-hopping method tends to be influenced [ that ] especially under the propagation environment of frequency-selective fading since it has the special feature that a carrier frequency changes, this effect can be reduced by this invention and the transmission quality is improved. Moreover, reliability of space diversity reception is made stable by checking a proper antenna for every packet. Thus, this invention can be called what can mainly contribute to improvement in the receiving engine performance of the spectrum diffusion signal by the low-speed frequency-hopping method.

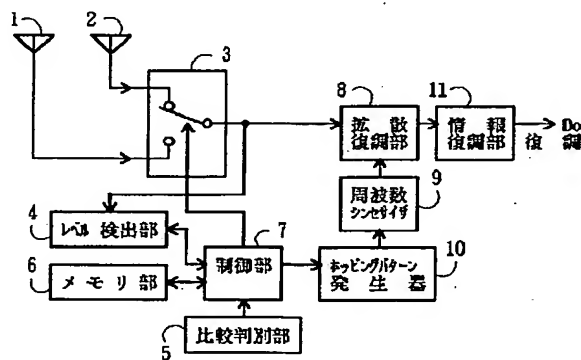
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## 【特許請求の範囲】

【請求項1】 周波数ホッピング方式のスペクトラム拡散信号を受信するスペクトラム拡散無線通信装置において、複数の受信アンテナと、前記複数の受信アンテナを切り換える切換回路と、前記複数の受信アンテナそれぞれごとに、ホッピングしてなる受信信号周波数それぞれの受信レベルを検出する受信レベル検出手段と、前記受信レベル検出手段で検出した受信アンテナごとの受信レベルを同じ周波数どうして比較し、いずれの受信アンテナの受信レベルが高いかにつき判別する比較判別手段と、前記比較判別手段で判別された受信レベルの高い受信アンテナを、ホッピングしてなる受信信号周波数ごとに対応せしめて記憶するメモリ部と、前記受信レベル検出手段、比較判別手段及びメモリ部とを制御するとともに、該メモリ部の記憶データをもとに、ホッピングしてなる受信信号周波数それぞれごとに受信レベルの高い側の受信アンテナへ切換設定するように前記切換回路を制御する制御部とを備えてなることを特徴とするスペクトラム拡散無線通信装置。

【請求項2】 前記受信レベル検出手段による受信レベルの検出を、受信信号におけるデータ期間開始前のブリアンブル期間で検出するようにしたことを特徴とする請求項1記載のスペクトラム拡散無線通信装置。

【請求項3】 前記ブリアンブル期間での受信レベルの検出を受信信号におけるバケットごとに行い、前記メモリ部の記憶データを更新するようにしてなることを特徴とする請求項2記載のスペクトラム拡散無線通信装置。

【請求項4】 前記制御部のもとにタイマ部を設け、前記ブリアンブル期間での受信レベル検出を前記タイマ部による所定時間の計測ごとに行い、前記メモリ部の記憶データを更新するようにしてなることを特徴とする請求項2記載のスペクトラム拡散無線通信装置。

【請求項5】 前記比較判別手段が、前記複数の受信アンテナのうち最後に切換選択する受信アンテナを除いた受信アンテナそれぞれの受信レベルを前記メモリ部に一旦記憶せしめ、同記憶してなる受信レベルと前記最後に切換選択した受信アンテナのレベルそれぞれとを比較判別するようにしてなることを特徴とする請求項1記載のスペクトラム拡散無線通信装置。

## 【発明の詳細な説明】

## 【0001】

【発明の属する技術分野】本発明はスペクトラム拡散無線通信装置に係り、より詳細には、主に低速の周波数ホッピング方式によるスペクトラム拡散信号の受信に適した空間ダイバーシティ受信に関する。

## 【0002】

【従来技術】ダイバーシティ受信技術は、フェーディング現象等の通信環境悪化の対処法の一つとして知られている。一方、スペクトラム拡散方式の通信分野においては、直接拡散スペクトラム拡散方式においてRAKE

受信方式が知られており、また、使用もされている。なお、上記RAKE受信方式は、アンテナを切り換えるという一般的なダイバーシティとは異なり、内部動作で機能するものであって、フェーディング現象により多重通路の各々通ってきた信号を識別し、信頼度の重み付けを行って合成するもので適応等化技術を使用したものである。つまり、受信信号の干渉性の歪みを除去しダイバーシティを実現する方法である。これに対し、周波数ホッピングスペクトラム拡散方式については搬送周波数がホッピングするという原理上の特質から直接拡散方式にくらべダイバーシティの実現が一般的に困難といえる。特に、特定の周波数範囲でフェーディング現象となる周波数選択性フェーディングのもとでは単にアンテナを切り換えるだけでは上記特質から効果が低い。

## 【0003】

【発明が解決しようとする課題】前述のように、周波数ホッピングスペクトラム拡散方式においては直接拡散方式にくらべダイバーシティの実現が一般的に困難といえる。本発明は上述に鑑みて、主に低速の周波数ホッピング方式によるスペクトラム拡散信号の受信に適した空間ダイバーシティを可能にしたスペクトラム拡散無線通信装置を提供することを目的とするものである。

## 【0004】

【課題を解決するための手段】本発明は、周波数ホッピング方式のスペクトラム拡散信号を受信するスペクトラム拡散無線通信装置において、複数の受信アンテナと、前記複数の受信アンテナを切り換える切換回路と、前記複数の受信アンテナそれぞれごとに、ホッピングしてなる受信信号周波数それぞれの受信レベルを検出する受信レベル検出手段と、前記受信レベル検出手段で検出した受信アンテナごとの受信レベルを同じ周波数どうして比較し、いずれの受信アンテナの受信レベルが高いかにつき判別する比較判別手段と、前記比較判別手段で判別された受信レベルの高い受信アンテナを、ホッピングしてなる受信信号周波数ごとに対応せしめて記憶するメモリ部と、前記受信レベル検出手段、比較判別手段及びメモリ部とを制御するとともに、該メモリ部の記憶データをもとに、ホッピングしてなる受信信号周波数それぞれごとに受信レベルの高い側の受信アンテナへ切換設定するように前記切換回路を制御する制御部とを備えてなるスペクトラム拡散無線通信装置を提供するものである。

【0005】また、前記受信レベル検出手段による受信レベルの検出を、受信信号におけるデータ期間開始前のブリアンブル期間で検出するようにする。

【0006】また、前記ブリアンブル期間での受信レベルの検出を受信信号におけるバケットごとに行い、前記メモリ部の記憶データを更新するようにする。

【0007】または、前記制御部のもとにタイマ部を設け、前記ブリアンブル期間での受信レベル検出を前記タイマ部による所定時間の計測ごとに行い、前記メモリ部

の記憶データを更新するようにしてもよい。

【0008】また、前記比較判別手段が、前記複数の受信アンテナのうち最後に切換選択する受信アンテナを除いた受信アンテナそれぞれの受信レベルを前記メモリ部に一旦記憶せしめ、同記憶してなる受信レベルと前記最後に切換選択した受信アンテナのレベルそれぞれとを比較判別するようにする。

【0009】

【発明の実施の形態】以下、発明の実施の形態を実施例にもとづき図面を参照して説明する。図1は本発明によるスペクトラム拡散無線通信装置の一実施例を示す要部ブロック図であり、受信アンテナを2組としたものである。また、図2は図1に関する説明図である。図1において、1は第1の受信アンテナ、2は第2の受信アンテナ、3は前記アンテナを切り換える切換回路、4は受信レベルを検出する受信レベル検出部、5は受信レベルの強弱を比較判別する比較判別部、6は比較判別部5の判別結果を記憶するメモリ部、7は前記切換回路3の切換制御と、比較判別部5及びメモリ部6等の制御とをなす制御部である。また、8は周波数ホッピング方式のスペクトラム拡散信号を復調する拡散復調部、9は拡散復調部8に所要周波数発振信号を供給する周波数シンセサイザ、10は前記制御部7の制御のもとに前記周波数シンセサイザ9の発振周波数を送信側のホッピングパターンに一致させるためのホッピングパターン発生器、11は情報復調(QPSK等の復調)をなす情報復調部である。

【0010】次に、本発明の動作について説明する。制御部7は2組の受信アンテナのいずれかを選択するよう切換回路3を設定する。この選択は予め定めておけばよく、本実施例では第1の受信アンテナ1を選択するものとする。第1の受信アンテナ1で受信された周波数ホッピング方式のスペクトラム拡散信号は受信レベル検出部4へ送られる。ここに周波数ホッピングのパターン1周期の周波数が、 $f_1 \rightarrow f_2 \rightarrow f_3 \rightarrow \dots \rightarrow f_n$ の順で変化するものとする。受信レベル検出部4は、第1の受信アンテナ1で受信された周波数 $f_1$ 乃至 $f_n$ の信号それぞれのレベルを検出する。この検出は図2(A)に示すプリアンプ期間に行うようにする。

【0011】このプリアンプ期間は図示のように、データ期間開始前に設けられており、その目的は主に、受信側において送信側と同期をとるための期間として使用するものである。この同期がとられた後に本来のデータ期間が開始される。また、受信レベル検出部4は、上記プリアンプ期間に使用アンテナの数に等しい回数のレベル検出を行う。従って、図1の場合、アンテナを2組としているので後述の第2の受信アンテナ2を含む2回のレベル検出を行うことになり、プリアンプ期間前半で第1の受信アンテナ1につき、後半で第2の受信アンテナ2につきそれぞれレベル検出する。第1の受信アンテナ1の受信レベルデータはメモリ部6に記憶してお

く、第1の受信アンテナ1の受信レベルを検出後、制御部7は切換回路3を第2の受信アンテナ2側へ切り換え、第1の受信アンテナ1の場合と同様、周波数 $f_1$ 乃至 $f_n$ の信号それぞれについてレベル検出する。

【0012】第2の受信アンテナ2の受信レベルを検出開始後、制御部7は比較判別部5において、2組のアンテナの受信レベルを同じ周波数どうして $f_1$ から $f_n$ まで比較させ、いずれの方がレベルが大きいかにつき判別させる。この比較判別は、例えば、第2の受信アンテナ2による $f_1$ のレベルを検出後、このレベルとメモリ部6に記憶してなる前記第1の受信アンテナ1による $f_1$ のレベルとを比較判別し、強い側のアンテナを $f_1$ と対応せしめてメモリ部6に格納する。同様の比較判別を $f_2$ から $f_n$ まで行い、各周波数と対応せしめて強い側のアンテナをメモリ部6に格納する。この結果、ホッピングパターン1周期の周波数( $f_1$ 乃至 $f_n$ )それぞれに対して設定(選択)する適正アンテナのデータがメモリ部6に格納される。図2(B)は上記比較判別を図示したものであり、ホッピングパターン1周期の周波数( $f_1$ 乃至 $f_n$ )に対し、第1の受信アンテナ1(A1)の受信レベルを $e_1$ 乃至 $e_n$ 、第2の受信アンテナ2(A2)の受信レベルを $e_1$ 乃至 $e_n$ とし、比較判別の結果としての「設定アンテナ」がA1又はA2であることを示す。上記設定アンテナデータをメモリ部6に格納後、制御部7は同データをもとにデータ期間[図2(B)]においてホッピング周波数( $f_1$ 乃至 $f_n$ )ごとに切換回路3を切り換え、受信レベルの強いアンテナ側へ設定する。

【0013】以上説明の受信レベルの比較判別を行うタイミングとして、例えば、バケットごとのプリアンプ期間に行い、メモリ部6の格納データを更新する。又は、制御部7の下にタイマ部(図示せず)を設け、所定時間ごとに上記比較判別を行い、同様にメモリ部6の格納データを更新するようにしてもよい。切換回路3で選択された受信信号は拡散復調部8へ入力し、スペクトラム拡散復調される。この復調の際に要する所要周波数の発振信号は周波数シンセサイザ9より供給され、また、該周波数シンセサイザ9の発振周波数はホッピングパターン発生器10のホッピングパターンに従う。なお、このホッピングパターンは送信側と同パターンであり、制御部7の制御の下に作動する。拡散復調部8よりの拡散復調出力は情報復調部11へ送られ、ここで情報復調(QPSK等に対する復調)され、データ $D_0$ の復調出力が得られる。以上のようにして、主に、低速の周波数ホッピング方式によるスペクトラム拡散信号の受信における空間ダイバーシティが可能となる。

【0014】

【発明の効果】以上説明したように本発明によれば、周波数ホッピング方式によるスペクトラム拡散信号の受信における空間ダイバーシティが可能になる。周波数ホッピング方式は搬送周波数に変化するという特質を有する

ことから周波数選択性フェーディングの伝搬環境下ではその影響を特に受け易いが、本発明によりこの影響を低減でき、伝送品質が改善される。また、適正アンテナの確認をバケットごとに行うことにより空間ダイバーシティ受信の信頼性を安定なものにする。このように、本発明は主に低速の周波数ホッピング方式によるスペクトラム拡散信号の受信性能の向上に寄与するものといえる。

【図面の簡単な説明】

【図1】本発明によるスペクトラム拡散無線通信装置の一実施例を示す要部ブロック図である。

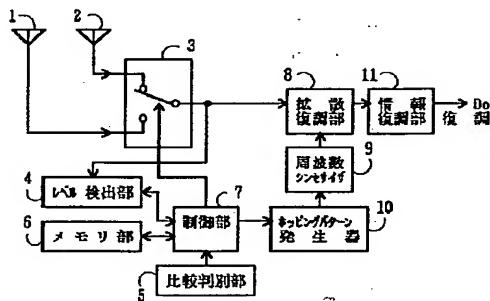
【図2】図1に関する説明図である。

【符号の説明】

\*

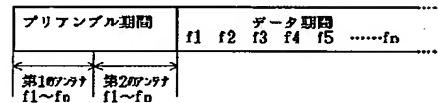
- \* 1 第1の受信アンテナ
- 2 第2の受信アンテナ
- 3 切換回路
- 4 受信レベル検出部
- 5 比較判別部
- 6 メモリ部
- 7 制御部
- 8 拡散復調部
- 9 周波数シンセサイザ
- 10 ホッピングパターン発生器
- 11 情報復調部

【図1】



【図2】

(A)



(B)

ホッピング周波数	f1	f2	f3	f4	f5	.....	fn
第1のアンテナ(A1)	B1	E2	E3	B4	B4	.....	En
第2のアンテナ(A2)	e1	e2	e3	e4	e5	.....	en
設定アンテナ	A1	A2	A2	A1	A1	.....	A2